Notes on the Biology of the Chinese Rose Beetle, Adoretus sinicus Burmeister in Hawaii[1]

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INTRODUCTION

The Chinese rose beetle was first observed in Honolulu about 1891 (Riley and Howard, 1893). It increased rapidly and by 1898 had become a serious problem on all islands (Koebele, 1899).

The immature stages have been described in detail (Habeck, 1963) but little has been published on the biology of this pest. Koebele (1898) wrote that the life cycle required six to seven weeks for completion in the summer at Honolulu. Of this, 7 to 10 days were required for incubation of the egg and 10 to 14 days for the pupal period, leaving only three to four weeks for development of the larval stages. Terry (1912) reported the incubation period as four days and the larval period as 77 days. Most of the other information available on *Adoretus* biology has been ably summarized by Williams (1931).

The studies reported here were undertaken to obtain information particularly on the life cycle. Adults were collected at night with the aid of a flashlight mainly from *Acalypha* sp. plants on campus. The beetles were placed in a cage made by placing a lantern glass over a 16 oz. specimen jar filled with moistened soil, and acalypha leaves were provided for food. Beetles readily oviposited in the soil which was sifted to remove the eggs. By transferring the beetles to a new cage after 24 hours, eggs were obtained which were no more than 24 hours old. Eggs were placed on the surface of moistened soil in two-ounce salve boxes for incubation and rearing of larvae.

Numerous problems were encountered while attempting to rear the larvae. A soil mixture of one part loam soil, one part dried cow manure, and one part compost with about 20 to 30 percent moisture proved to be most satisfactory, and no additional food was required. The frequent handling necessary for making observations undoubtedly greatly increased the mortality, especially in the first instar.

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LIFE HISTORY

EGGS

Eggs were laid throughout the soil at all depths in laboratory jars; however in the field the few eggs found were all within 1.5 inches of the surface. The depth at which oviposition occurs is likely to depend upon the texture and firmness of the soil. While sifting for eggs, females were frequently encountered ovipositing. The ovipositor extrudes three to four millimeters and makes a small pocket in the soil about three times the size of the egg which is deposited therein. Frequently four to six such egg pockets are found in close proximity.

The incubation period varies with temperature (table 1). The shortest incubation period at a mean temperature of 83.4° F was seven days; at a mean temperature of 75.2° F no hatching occurred before the twelfth day. These figures indicate that the incubation period of four days reported by Terry is considerably shorter than would be expected. The only information obtained for percent of hatch was 85.3 percent. This is probably a low figure since some of these eggs may have been damaged during handling. The hatching process requires only four or five minutes to complete after the chorion is broken. The mandibles, which are well developed and readily visible during the last days of the egg stage, apparently play no part in rupturing the chorion. A hatching spine is present on the metathorax, but the part it plays in breaking the chorion was not determined.

Table 1. Incubation period for eggs of Adoretus sinicus

Mean Temp. °F	No. Eggs	Percent Hatch	Days									
			7	8	9	10	11	12	13	14	15	16
75.2	191	85.3						21	67	70	4	1
83.4	352=*		3	54	147	103	28	10	7			

* Actual total and percent hatch not determined.

LARVA AND PUPA

Three larval instars occur in this species as in most Scarabaeidae. First instar larvae burrow into the soil after hatching and soon begin to feed. Frequent checking (daily or every other day) of the larvae gave more exact information on the duration of each stage but mortality was high and few survived beyond the second instar. Checking larvae at five- to seven-day intervals was less accurate, increasing the plus or minus factor considerably but more larvae completed their development using this system. Data from two series, one checked every other day and the other checked at five to seven day intervals (table 2), are quite similar.

Development from egg to adult required from 92 ± 2.0 to 126 ± 2.0 days with an average duration of 106.2 ± 2.0 days. This is considerably longer than the six to seven weeks for a cycle reported by Koebele. Average duration of the

Table 2. Average duration of the immature stages of A. sinicus

Stage	Feb. 10–May 15*		Dec. 15–Apr. 25**	
	No. Records	Days	No. Records	Days
Egg	45	13.4 ± .0	8	11.9 ± 2.5
1st Instar	45	19.6 ± .7	8	22.8 ± 3.2
2nd Instar	35	16.8 ± .9	21	14.5 ± 6.3
3rd Instar	2	34.3 ± .8	21	44.4 ± 4.6
Pupa	1	11.0 ± .0	21	14.1 ± 1.6
Total	1	93.0 ± .3	21	106.2 ± 2.0

* Examined at 2-day intervals.
** Examined at 5- to 7-day intervals.

immature stages of males was about 2.5 days less than for females but this difference was not statistically significant. The second instar required the least time for development and the duration of the third instar was about equal to that of the first and second instars combined.

Larvae were commonly found in lawns, gardens and flower beds where considerable humus was present; few were found in cultivated fields. Although larvae were fairly abundant in the barnyard soil at Waimano Home, they were never found in decaying manure piles where the larvae of *Protaetia fusca* Herbst were plentiful.

A prepupal period begins about five days before pupation. Pupae were always found within the split larval skin. Duration of the pupal stage ranged from 11 to 17 days averaging about 14 days.

Adults

Newly emerged adults remained in the soil and did not feed for three to five days. When virgin male and female adults were placed together four days after emergence, seven days passed before oviposition occurred. Little information was obtained on egg production from these reared adults; however, six field-collected females, each caged with an individual male, laid from 22 to 89 eggs, averaging 54 eggs. The maximum number of eggs laid in one week was 28. Field-collected adults lived as long as eight weeks in the laboratory.

Sex ratio of reared adults was not significantly different from the expected 1:1 ratio. Twenty-one males and 17 females were reared. Through the courtesy of Mr. Don Awai of the Board of Health, Chinese rose beetles collected in the New Jersey type mosquito light traps were dissected to determine the sex ratio. The number of females was significantly greater than the number of males (table 3). No records were kept concerning number of eggs remaining in the

Table 3. Sex ratios of A. sinicus collected in light traps

Time–Place	Total Number Determinable	Percent	
		Males	Females
Summer (June 18–July 26) Oahu, 25 locations	249	26.9	73.1
Winter (November 27–January 14) Oahu, 16 locations	344	36.6	63.4
October 15–21 Kauai, 3 locations	207	14.5	85.5
Total	800	27.9	72.1

females, however, it was observed that most of these females had either no eggs or few eggs remaining in the ovaries indicating that, like many other insects, they are not attracted to the lights until they have laid their eggs.

FOOD PLANTS

The Chinese rose beetle is a general feeder, a fact which led Koebele (1898) to observe that the food plants were too many to enumerate and that it would be far easier to list those plants which were not attacked. About 55 different plants have been recorded as food plants, most of these cultivated crops or common ornamental plants.

The injury caused by the feeding of this insect is very characteristic and most of the new food plant records are based on damage rather than observation of feeding. Most of the observations were made on the University of Hawaii campus and at Foster Gardens.

In addition to those food plants already recorded, injury or feeding has been observed on 200 other plant species for a total of 255 food plants representing 56 plant families. This total is only a fraction of the actual number of food plants which might easily number six or seven hundred. The commonly attacked plant families and the number of records from each are Leguminosae, 36; Combretaceae, 19; Myrtaceae, Sterculiaceae, and Zingiberaceae, 15 each; Malvaceae and Musaceae, 14 each. Some of the favorite food plants previously unrecorded are strawberry, *Fragaria* sp.; Rangoon creeper, *Quisqualis indica* L.; plumbago, *Plumbago capensis* Thunb.; maile pilau, *Paederia foetida* L.; sea grape, *Coccolobis uvifera* (L.) Jacq.; cacao, *Theobroma cacao* L.; macaranga, *Macaranga grandiflora* (Blco.) Merr.; as well as most species of *Bauhinia*, *Combretum*, *Hedychium*, *Heliconia*, *Hibiscus*, and *Terminalia*. Young paperbark trees, *Melaleuca leucadendron* L., two to four feet high were severely injured, though no damage was observed on larger trees. Castor bean, *Ricinus communis* L., and other plants may be completely uninjured in one area and heavily attacked in another. The fact that plants, such as banana, already attacked by this beetle are apparently more attractive to other beetles than uninjured plants (Pemberton, 1959) may explain why some plant species not normally fed upon may be injured extensively at times. It is interesting that an insect with such general feeding habits will show a decided preference for certain varieties of a species even when that species apparently is a favored food plant such as soybean. The food habits of this insect present some interesting problems for further research.

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